

**SURGICAL TREATMENT OF OTITIS MEDIA***LIU Jun*

Otitis Media is a common disease in the practice of otolaryngology and one of the famous "three inflammations and one deafness". Otitis media has been with humans from the very beginning. Treatment for otitis media started in the west in 1774 and much later in China. Surgical treatment for otitis media was initially to save life and produce dry ears (i.e. to eradicate disease), to control infection and to prevent complications<sup>[1]</sup>. As our understanding of middle ear physiology and pathology increased, as well as advent of antibiotics and the surgical microscope, surgical treatment of otitis media has moved from merely saving life into a time of true microscopic ear surgery and of preserving or restoring auditory function, and from an invasive to a minimal invasive time. At this time, it continues move into a new stage of auditory implantation<sup>[1-3]</sup>.

Since its opening in 1959, the PLA General Hospital Department of Otolaryngology Head and Neck Surgery has always focused on the prevention and treatment of deafness. Its treatment of otitis media has maintained a leading position in China.

**Active basic and clinical research regarding surgical treatment of otitis media to promote its development**

Research leads patient care. Basic and clinical research on middle ear anatomy, histopathology and middle ear auditory physiology has been a key to improvement of treatment outcomes in otitis media. Prevention and treatment of deafness has been the focus of this department. Even at its very early times, with only 13 beds, the department built a laboratory for research on prevention and treatment of deafness. Over the next 50 years, the department made great achievements in studying the middle ear anatomy, physiology and histopathology<sup>[4-9]</sup>, which served as the foundation for development of microscopic ear surgery and neurotology.

Since the opening of the laboratory, multiple animal and cadaver studies have facilitated development of surgical techniques. We were the first to study tissue reaction to retained gelfoam and erythromycin in the middle ear cavity in tympanoplasty procedures, which provided scientific support for broad practice of packing the middle ear space with erythromycin gelfoam. We also studied histological changes in feline incus allograft and designed stapes prosthesis for hearing reconstruction.

**Close relations among the advances of clinical audiology and medical imaging and progress in surgical treatment of otitis media**

Improvement of pre-operative evaluation and diagnosis in otitis media has greatly helped understanding of patient condition and prediction of treatment results. Improvement of clinical audiology has also facilitated progress of diagnosis of otitis media. From its early days, the department has set up a clinical audiology center, with ever increasing number of tests including pure tone audiometry, acoustic immittance, otoacoustic emissions, multi-frequency steady-state responses, bone conduction auditory brainstem responses, speech audiometry, high repetition rate ABRs and vestibular evoked myogenic potentials<sup>[10-17]</sup>.

In the old days, X-ray images were used for diagnosis of otitis media, including Schuller's and Mayers' projection images, X-Rog photograph and multi-orbit tomography<sup>[18]</sup>. Head CT was introduced in 1975. Available imaging technologies today include high-resolution temporal bone CT, head MRI, PET-CT (and three-dimensional reconstruction)<sup>[19]</sup>. Temporal bone CT provides information on disease location, size, mastoid pneumatization, ossicular chain position and involvement, thickness of squamous bone, location of the sigmoid sinus, malformation of the cochlea, enlarged vestibular aqueduct,

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promontory thickness, size of the internal auditory canal, status of the Eustachian tube, and the course of the facial nerve. It facilitates early diagnosis of otitis media and latent pathologies, allowing early intervention. Intraoperative CT and MRI provide means to identify anatomical landmarks when facing inner ear and facial nerve malformation and is a very useful tool in microscopic ear surgery to minimize complications.

### **Development of proper classification of diagnosis and surgical treatment of otitis media**

Classification in diagnosis and surgeries for otitis media has always been controversial and is still evolving through studies<sup>[20]</sup>. There is no final classification standard at this time<sup>[21-23]</sup>. Our department has played a leading role in formulating an otitis media classification standard as commissioned by the Chinese Medical Association<sup>[24, 25]</sup>. The new standard classifies otitis media as acute, chronic, cholesteatoma and residual types<sup>[25]</sup>, and otitis media surgeries as 1) open mastoidectomy and tympanoplasty (or simple mastoidectomy), 2) close mastoidectomy with or without tympanoplasty, and 3) epitympanotomy including myringoplasty, ossicular chain reconstruction and vestibular fenestration. This department has made significant contributions to standardizing diagnosis and treatment of otitis media.

### **Continuous improvement in the theory, methodology, tools and materials for surgical treatment of otitis media**

Advance of treatment for otitis media in this department is similar to that in the rest of the world. Initially, treatment was primarily focused on disease eradication, infection control and complications prevention. Simple mastoidectomy was performed at the opening of the PLA General Hospital in 1953 to establish drainage from the middle ear and mastoid and to prevent complications. Due to lack of operative microscope, power drill and other microscopic surgery instruments, complete disease elimination and hearing reconstruction were not always successful. Breakthrough was made in 1959 with the purchase of operative microscopes and design and production of home-made microscopic surgery instruments. Standard mastoidectomy, myringoplasty and ossicular chain reconstruction were started and the department gradually took lead in the diagnosis and treatment of otitis media in China. In 1973, we published an article in the Journal of Chinese Medicine on indications for tympanoplasty and techniques of myringoplasty and ossicular chain reconstruction, as well as perioperative man-

agement. The article for the first time provided details on utilizing the mastoid periosteum and other mesodermal tissues in myringoplasty and on utilizing ossicular and other bony autograft in reconstructing the ossicular chain, as well as their advantages and operational techniques<sup>[1,2]</sup>. Based upon this information, improved tympanoplasty techniques were proposed, especially for hearing reconstruction.

The advance of surgical treatment for otitis media has been closely linked to the development of hearing reconstruction methodologies in semicircular canal fenestration and stapedectomy procedures for otosclerosis. In 1893, Adam Politzer (father of modern day otology) was the first to name otosclerosis. In 1923, Gunnar Holmgren invented semicircular canal fenestration, which was started in China in the 1940s by late Prof. JIANG Sichang and improved hearing in patients with otosclerosis. However, this procedure forewent the amplification by the tympanic membrane and ossicles and left an open mastoid cavity that required regular debridement. Stapedectomy was successfully completed in 1962 in China, which was good news for patients with stapes fixation from various etiologies<sup>[26, 27]</sup>. Research and clinical experiences with treatment of otosclerosis deepened our understanding of middle ear amplification mechanisms and other physiological functions and provided theoretic support for the advances of tympanoplasty and hearing reconstruction.

Based upon the Wullstein's classification of tympanoplasty procedures, we have developed a relatively simple tympanoplasty classification system, i.e. Type I-simple myringoplasty, Type II-myringoplasty plus ossicular chain reconstruction using incus autograft or ossicular allograft or artificial prosthesis to link the malleus to the stapes, and Type III-myringoplasty plus ossicular chain reconstruction using ossicular graft to connect the tympanic membrane to the stapes or footplate<sup>[20, 22-24]</sup>.

New materials for myringoplasty and hearing reconstruction in otitis media have been continuously invented. Our group is among the first in China to use mesodermal tissue grafts, including temporalis fascia, mastoid periosteum, tragal cartilage, perichondrium and pre-treated artificial fascia grafts, for myringoplasty to mitigate disadvantages of skin graft and to improve treatment success rate. Artificial ossicles prostheses have now been widely adopted<sup>[28, 29]</sup>, especially the titanium prostheses. Advantages of titanium prostheses include light weight, high strength, certain level of plasticity, good biocompatibility, resistance to infection, stability and good sound transduction property<sup>[28]</sup>. It is useful in solving some of the difficulties in tympanoplasty, such as unavailable stapes supra structure, and ischemia, re-absorption and instability of ossicles autografts. We have also developed and

patented various hearing reconstruction materials (e.g. artificial stapes and annulus prostheses).

Temporal bone microscopic anatomy and pathology research are key parts of the training for an otologist. By department requirements, this part of training is mandatory for residents and graduate students. A "Head and Neck Anatomy and Temporal Bone Surgery" training manual has been compiled for this purpose and numerous courses offered each year. A three dimensional temporal bone anatomy and imaging system has been developed for teaching and training purposes. We have published books entitled "Neurotology and Lateral Skull Base Surgery", "Three Dimensional Atlas of Microscopic Ear Surgery" and "Three Dimensional Anatomy of the Temporal Bone", which are also used in teaching courses and resident training.

The concept of "minimal invasive" in microscopic ear surgery needs to be further improved. Over the past decade, endoscopy, CO2 laser and stereotactic guidance have been adopted by our group, with satisfying results. High resolution microscopes, intraoperative facial nerve monitoring, intraoperative MRI and CT scanning, stereotactic guidance and intraoperative three dimensional imaging are all infrastructures that will support "true minimal invasive" procedures to improve treatment outcomes and minimize complications.

### **A new stage of "auditory implantation" for surgical treatment of otitis media**

In cases where hearing reconstruction is not possible after eradication of middle ear diseases, or because of coexisting ear canal atresia and severe middle ear malformation, hearing aids are often not helpful. For such cases, development of implantable hearing devices such as BAHA<sup>[31]</sup> and vibrant soundbridge (VSB)<sup>[32,33]</sup> has attracted great interests from both patients and surgeons. In May of 2010, and together with Beijing Tongren Hospital, our group became the first to start VSB implantation in China on a female patient with mixed hearing loss and achieved satisfying results<sup>[32, 33]</sup>. We have so far performed over 30 VSB implantations, which are useful for patients who cannot benefit from traditional middle ear surgeries. Cochlear implant has opened a new horizon for hearing-speech rehabilitation in sensorineural hearing and provides an opportunity for many patients to return to the world of sounds and even regain close to normal communication capabilities. From 1996, we have implanted multi-channel implants for more than 1,700 patients with anticipated outcomes in most patients.

### **Extension of microscopic ear surgery to neurotology and lateral skull base surgery**

## **subspecialties**

Advances in surgical treatment of otitis media have promoted development of microscopic ear surgery. For many years, our group has applied microscopic ear surgery technologies in the treatment of acoustic neuroma, facial paralysis, facial nerve tumors, and trigeminal or glossopharyngeal neuralgia. Since our first translabyrinthine acoustic neuroma resection case in 1978, we have performed more than 300 acoustic neuroma resection procedures with complete resection in 95% and facial function preservation in 75% of these cases, as well as steadily improving hearing preservation. Surgical treatment of temporal bone and related tumors has become common procedures in lateral skull base surgery. The department has set up subspecialty groups including microscopic ear surgery, neurotology and lateral skull base surgery with 60 beds deployed, which provide subspecialty training for surgeons and targeted care for patients.

Looking back, we have accomplished great achievements in the diagnosis and treatment of otitis media in the past 50 years. Along with the establishment of subspecialty groups and expansion of our ward units, our operation volume has greatly increased. Middle ear surgeries have increased from 30/month in the early years to currently 180/month, with significantly improved treatment outcomes. Limited by materials, equipment and techniques, early middle ear surgeries focused on eradication of diseases, with attempts to restore hearing only in cases with optimal conditions. Now, with improvement in materials, equipment and techniques, surgical treatment efficacy has improved to over 95%, with continuous advances toward minimal invasive and hearing restoration. The rate of primary hearing reconstruction in cholesteatoma has greatly increased in our hands.

Despite the great achievement in the diagnosis and treatment of otitis media, many difficulties remain, including management of Eustachian tube occlusion, long term management of otitis media with adhesion, epithelialization of tympanic cavity (loss of mucosa) and recurrence of cholesteatoma after intact canal wall mastoidectomy. Others difficulties include resistance to drug treatment and perioperative issues. All these need to be addressed through the efforts by all otologist colleagues, especially those who are dedicated to basic science and clinical research.

## **References**

- [1] Yang Wei-Yan. Surgical Treatment of Otitis Media. Continuing Medical Education, 2006, 20(20): 48-50.
- [2] Department of Otolaryngology Head and Neck Surgery of Chinese PLA General Hospital. tympanoplasty. National Medical Journal of China, 1973, 10: 584-596.

- [3] Ma Fu-Rong.Surgical treatment of otitis media.ZHONGGUO YIXUE WENZHAI ER BI YANHOU KEXUE ,2006, 21(6): 327-331.
- [4] Tian Zhong-Rui.Measurement of ossicles and ossicular reconstruction.Chinese Journal of Otorhinolaryngology Head and Neck Surgery,1979,14(1):1-6. 5
- [5] Jiang Si-Chang,Gu Rui,Dai Pu.Computer three-dimensional reconstruction using consecutive temporal bone histological sections.Chinese Journal of Otorhinolaryngology Head and Neck Surgery,1991,26(4):238-241.
- [6] Dai Pu,iang Si-Chang,Gu Rui,et al.Computer three dimensional reconstruction of ossicles and a mechanical dynamic model.Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1991,26(5):272-274.
- [7] Huang De-Liang,Jiang Si-Chang,Yang Wei-Yan,et al.Histopathology of the temporal bone in adhesive otitis media. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1996,31 (5):287-290.
- [8] Jiang Si-Chang,Dai Pu,Liu Yang,et al .3 D Morphological Study of the Temporal Bone. National Medical Journal of China, 1997,77(8):579-582.
- [9] Jiang Si-Chang.Histopathological changes in chronic otitis media with suppurative labyrinthitis. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1984, 19(1):19-20.
- [10] Chen Xin.Clinical utility of acoustic immitance audiometry. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1979,14(2):77-82.
- [11] Gu Rui.Basics of audiology and pure tone thresholds testing. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1991,26(1):55-58.
- [12] Chen Xin.Utility of tympanography in diagnosis of middle ear fluid.Chinese Journal of Otorhinolaryngology Head and Neck Surgery,1981,16(2):76-78.
- [13] Han Dong-Yi,Yang Wei-Yan.Adoption of speech audiometry in improving otologic diagnosis and treatment. Chinese Journal of Otology,2008,6(1):7-8.
- [14] Fu Bao-Tian.40HzNormative data of auditory related potentials.Chinese Journal of Otorhinolaryngology Head and Neck Surgery,1988,23(3):156-158.
- [15] Shi Yong-Bing,Jiang Si-Chang,Gu Rui,et al.Otoacoustic emissions in normal young Chinese.Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1989,24(6):349-351.
- [16] Gu Rui.Acoustic immitance audiometry in testing Eustachian tube function in ears with ear drum perforation.Chinese Journal of Otorhinolaryngology Head and Neck Surgery1987, 12(1):33-35.
- [17] Chen Xin.A few parameters in acoustic reflex among Chinese. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 1986,21(4):300-302.
- [18] Wang Yu-Lin, Wang Xin-Jiang, Zhao Qian, et al.Three-dimensional reconstruction of inner ear by using 64 multi-detector CT.Chinese Journal of Interventional Imaging and Therapy, 2008, 5(5):361-363.
- [19] Zhang Xiao-Jing,Lou Xin,Zhang Ai-Lian,et al.The Application of Three-Dimensional Reconstruction of Inner Ear MRI in Evaluation of Semicircular Duct.Chinese Journal of Medical Imaging, 2011, 19(4):304-306.
- [20] Yang Shi-Ming,Yuan Hu.Classification, diagnosis and treatment of otitis media.Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 2007,42(7):554-555.
- [21] Yu Li-Sheng,Han Chao-Gang.Classification of middle ear surgery and some basics.Chinese Journal of Otology, 2004,2 (4) : 280-284.
- [22] Yang Wei-Yan,Su Zhen-Lun. "Otitis media" - a never-ending topic of discussion.Chinese Journal of Otology, 2004,2 (4) : 243-244.
- [23] Yang Wei-Yan.Surgical Treatment of Conduction Deafness. Continuing Medical Education,2006,20(20):51-53.
- [24] Yang Wei-Yan.Direction of the development of otomicrosurgery. Chinese Journal of Otorhinolaryngology Head and Neck Surgery,2009,44(5):353-354.
- [25] Editorial Board of Chinese Journal of Otology Head and Neck Surgery.Diagnostic and Therapeutic Protocol Classification and typing of otitis media. Chinese Journal of Otorhinolaryngology Head and Neck Surgery, 2005, 40:5.
- [26] Fang Yao-Yun,Yang Wei-Yan,Zhang Su-Zhen,et al.A preliminary report on stapedectomy for tympanosclerosis. Chinese Journal of Otorhinolaryngology Head and Neck Surgery,1990,25(2): 83-85.
- [27] Jiang Si-Chang.A discussion on histopathological changes of stapes in otosclerosis. Chinese Journal of Otorhinolaryngology Head and Neck Surgery 1983,(3):142-145.
- [28] Goldenberg RA. Ossiculoplasty with Composite prostheses: PORP and TORP. Otolaryngol Clin North Am, 1994,27: 727-746.
- [29] Yang Shi-Ming,Yu Ya-Ping,Han Dong-Yi.Effects of ossicular reconstruction with partial ossicular replacement prosthesis in tympanoplasty. Chinese Journal of Otology, 2007,5(2) : 141-144.
- [30] Yang Shi-Ming,Han Dong-Yi,Yang Wei-Yan.Endoscopic minimal invasive ear surgeries.The Journal of Practical Medicine2005, 21(2):113-114.
- [31] Lei lei, Ji Fei, Xi Xin, et al. Development and utility of BAHA. Chinese Journal of Otology2003,1(4):38-41.
- [32] Liu Jun.Partial implantable middle ear hearing aid -Vibrant Soundbridge. Chinese Journal of Clinicians(Electronic Edition), 2011,5(2):5-7.
- [33] Liu Jun,Li Wan-Xin,Hong Meng-DI,et al.A case study of the vibrant soundbridge implantation in China. Chinese Scientific Journal of Hearing and Speech Rehabilitation, 2010, 43 (6) : 57-59.

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